

AMENDMENTS TO THE SPECIFICATION

Replace the paragraph at page 2, lines 15-28 with the following amended paragraph:

Compression ignition diesel engines have great utility and advantage as vehicle power plants because of their inherent high thermal efficiency (i.e. good fuel economy) and high torque at low speed. Diesel engines run at a high A/F (air to fuel) ratio under very fuel lean conditions. Because of this they have very low emissions of gas phase hydrocarbons and carbon monoxide. However, diesel exhaust is characterized by relatively high emissions of nitrogen oxides (NOx) and particulates. The particulate emissions, which are measured as condensed material at 52EC°C, are multi phase being comprised of solid (insoluble) carbon soot particles, liquid hydrocarbons in the form of lube oil and unburned fuel, the so called soluble organic fraction (SOF), and the so called "sulfate" in the form of $SO_3 + H_2O = H_2SO_4$.

Replace the paragraph at page 3, lines 4-30 with the following amended paragraph:

One commercial aftertreatment technology which has proven very successful for reduction of NOx under lean exhaust conditions for stationary sources is Selective Catalytic Reduction (SCR). In this process NOx is reduced to N_2 with NH_3 over a catalyst (e.g. zeolite, V/Ti). This technology is capable of NOx reduction in excess of 90% and thus it is one of the best candidates for meeting the aggressive NOx reduction goals. SCR is currently under development for mobile source, vehicle applications using urea (e.g. aqueous solution) as the source of NH_3 . SCR is very efficient for NOx reduction as long as the exhaust temperature is within the active temperature range of the catalyst (e.g. $> 300EC^\circ C$). Unfortunately diesel exhaust temperatures are many times considerably lower than that required for good catalyst efficiency (i.e., below "light-off"). This is especially true for

light duty (LD) diesel applications such as diesel autos which operate at light load for the most part, resulting in very low exhaust temperatures (150-250°C). Even diesel trucks operate under conditions which result in exhaust temperatures below the optimum temperatures for SCR catalysts. Unfortunately, one of the best, most stable, SCR catalysts, which is of the zeolite type (e.g. The assignee, Engelhard Corporation's ZNX catalyst, a Fe-Beta Zeolite), also has the highest optimum operating temperature. As a result its effectiveness is greatly diminished at diesel exhaust temperatures of interest.

Replace the paragraph at page 4, lines 1-31 with the following amended paragraph:

One key aftertreatment technology under development for very high level particulate reduction is the diesel particulate filter. There are many known filter structures that can be used to remove particulates from diesel exhaust, including honeycomb wall-flow filters, wound or packed fiber filters, open-cell foams, sintered metal filters, etc. However, ceramic wall-flow filters have received the most attention. These filters are capable of removing over 90% of the particulate material from diesel exhaust and thus can meet this emissions reduction goal. The filter is a physical structure for removing particles from exhaust and the accumulating particles will increase the back pressure from the filter on the engine. Thus the accumulating particles (soot + hydrocarbons) have to be continuously or periodically burned out of the filter to maintain an acceptable backpressure level. Unfortunately, the carbon soot particles require temperatures in excess of 500-550°C to be combusted under oxygen rich (lean) exhaust conditions. This is higher than typical diesel exhaust temperatures. A means must be provided to lower the soot burning temperature in order to provide for "passive" regeneration of the filter. One good way to accomplish this is to provide a suitably formulated catalyst which is applied to the filter. The presence of the catalyst has been found to provide soot combustion and thereby

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regeneration of the filter at temperatures accessible within the diesel engine's exhaust under realistic duty cycles. In this way a Catalyzed Soot Filter (CSF) or Catalyzed Diesel Particulate Filter (CDPF) can be an effective way to provide for >90% particulate reduction along with passive burn-out of the accumulating soot and thereby filter regeneration.

Replace the paragraph at page 5, line 9 to page 6, line 6 with the following amended paragraph:

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Hug Engineering AG has developed a gas purification stationary system described in SAE paper 930363, "Off-Highway Exhaust Gas After-Treatment Combining Urea-SCR, Oxidation Catalysis and Traps". In this system, NH₃ is injected upstream of catalyst beds containing an SCR followed by an oxidation catalyst. In a later Hug brochure (1996) a soot filter bed (optional) is provided in a casing adjacent to and upstream of a SCR reactor adjacent to and upstream of an oxidation catalyst and the urea injected into the waste gases passing through, in sequence, the filter, SCR and oxidation catalyst. The soot filter is described as a fibrous bundle which filters fine soot particles from the exhaust stream that have a carcinogenic effect. The Hug system disclosed has been applied to a ferry and other large diesel engine applications operating for the most part at steady speeds and higher temperatures than the vehicular applications of the present invention. A Hug brochure for stationary gas purification systems describes Hug's "Staru" system in which the soot filter is split from the SCR and oxidation catalysts with NH₃ injected therebetween. The soot filter described as fibrous to continue the function of trapping fine soot particles but is catalytically coated to regenerate or burn off the soot at 450°C. In general, the Hug systems have shown the ability to reduce NOx exhaust emissions from large diesel engines operating generally steady state at higher temperatures than light duty diesel engines by injecting NH₃ upstream of SCR-oxidation catalysts and using a downstream fibrous, regeneration filter to trap fine soot particles.

Replace the paragraph at page 8, lines 13-22 with the following amended paragraph:

B⁵
An important factor of this invention is the discovery that there is an important synergy between the CSF and the SCR catalyst in that the presence of the CSF up-stream of the SCR catalyst significantly enhanced the NOx reduction performance of the SCR catalyst. In this configuration the ZNX SCR catalyst exhibited higher NOx conversion than the SCR catalyst alone at all temperatures, plus it extended the effective NOx conversion range of the ZNX SCR catalyst down to temperatures at least as low as 200°C which is well below the effective temperature range of the ZNX catalyst alone.

Replace the paragraph at page 10, lines 10-16 with the following amended paragraph:

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Figure 2 is a plot of graphs of engine test results comparing NOx conversion performance of an exhaust system using an SCR catalyst alone and an exhaust system using CSF and SCR catalysts as a function of NSR at 470°C inlet temperature for the engine of Figure 1 operated under 100% load at 1,800 rpm producing engine out NOx of 780 ppm at space velocity of 51.33k hr⁻¹;

Replace the paragraph at page 10, lines 22-28 with the following amended paragraph:

B⁷
Figure 4 is a plot of graphs similar to Figure 2 showing engine test results comparing NOx conversion performance of exhaust systems having only an SCR catalyst and CSF and SCR catalysts as function of NSR at 345°C SCR inlet temperature for the engine of Figure 1 operated under 60% load at 1,800 rpm producing engine out NOx of 400 ppm at space velocity of 46.94k hr⁻¹;

Replace the paragraph at page 11, lines 3-9 with the following amended paragraph:

Figure 6 is a plot of graphs similar to Figures 2 and 4 showing NOx conversion performance of an exhaust system having only an SCR catalyst and an exhaust system having the CSF and SCR catalysts as a function of NSR at 200°C SCR inlet temperature for the engine of Figure 1 operated under 14% load at 1,800 ppm producing engine out NOx of 200 ppm at space velocity of 28.33k hr.-1;

Replace the paragraph at page 13, lines 9-26 with the following amended paragraph:

The soot filter substrate used for the tests was an EX-80 cordierite wall-flow filter purchased from Corning Inc. The substrate was 10.5" in diameter and 12.0" long. This filter had a total volume of 17.03 liters (1039 in³) or 2.4 times the swept displacement of the engine. It had a honeycomb cell spacing of 100 cpsi with a 17 mil wall thickness. The soot filter catalyst used for the tests was the assignee, Engelhard Corporation's, filter catalyst designated MEX 003. This catalyst is comprised of 250 g/ft³ ZrO₂ applied to the soot filter substrate by solution impregnation as zirconium acetate solution and then dried, plus 500 g/ft³ CeO₂ applied next by solution impregnation as cerium (III) nitrate/citric acid solution (Ce: citrate mole ratio = 1:1) and then dried and calcined at 450°C, plus 75 g/ft³ platinum applied by solution impregnation as amine-solubilized Pt(II) hydroxide (i.e. Pt "A" Salt) which was then dried and calcined at 450°C. This comprised the catalyzed soot filter in the preferred embodiment or CSF 12.

Replace Table 1 at page 16, lines 10-17 with the following amended Table 1:

Table 1
Steady State Speed of 1800 rpm

Load	SCR Cat Inlet T	Exhaust Flow (SCFM)	SCR Cat GHSV (1000 Hr-1)	NOx (ppm)	Figures
14%	200EE°C	285	28.3	214	6,7
60%	345EE°C	471	46.9	420	4,5
100%	468EE°C	515	51.3	770	2,3

Replace the paragraph at page 16, line ²⁷2 to page 17, line 19 with the following amended paragraph:

Figure 2 shows the NOx conversion levels as a function of NSR for the CSF and ZNX SCR configuration indicated by the trace passing through circles designated by reference numeral 30 and for the ZNX SCR catalyst configuration alone indicated by the trace passing through diamonds designated by reference numeral 31 at the 100% load/468EE°C SCR inlet condition. As can be seen there appears to be a slight advantage for the CSF and ZNX catalysts configuration, but the NOx conversion performance of both systems is very similar. The NOx conversion levels are essentially at or slightly above theoretical for the calculated NSR level thus showing very high level utilization of the urea reductant and thereby very high NOx conversion. Note from Table 1 that the exhaust inlet temperature of 468EE°C is well within the ZNX SCR catalyst temperature window for optimum catalyst activity.

The addition of CSF catalyst 12 does not materially change the NO₂ conversion efficiency which would be expected. That is, one would expect the SCR catalyst to perform within its operating temperature window and improved results by addition of an upstream catalyst should not occur.

Replace the paragraph at page 17, line 20 to page 18, line 5 with the following amended paragraph:

B12
Figure 3 shows the maximum NH₃ break through levels as a function of NSR for the same runs at 100% load/468°C SCR inlet condition. As can be seen NH₃ break through for the ZNX SCR catalyst alone configuration is very low to at least an NSR level of ca. 0.7. However, at an NSR of ca. 0.96 the ZNX alone configuration indicated by the trace passing through diamonds designated by reference numeral 34 exhibits a maximum NH₃ break through of nearly 40 ppm. The goal should be to keep NH₃ slip at all times below ca 20 ppm and preferably below 10 ppm. The CSF and ZNX configuration, on the other hand, indicated by the trace passing through diamonds designated by reference numeral 35 exhibited no (0 ppm) NH₃ break through at all NSR levels. This is somewhat surprising because both systems (SCR along and CSF and SCR showed similar NOx conversion ranges) and shows a clear advantage to the continuation of CSF catalyst 12 upstream of SCR catalyst 14 for preventing ammonia slip.

Replace the paragraph at page 18, line 6 to page 19, line 20 with the following amended paragraph:

B13
Figure 4 shows NOx conversion as a function of NSR for the CSF 12 and SCR 14 catalyst arrangement which is shown as the trace passing through circles designated by reference numeral 36. When the emission system was only SCR 14 by itself, the NOx conversion is shown as the trace passing through diamonds designated by reference numeral 37. Traces 36, 37 were developed with engine 15 at the 60% load/345°C SCR inlet condition. As can be seen, at low NSR ratios, CSF and ZNX SCR trace 36 exhibits only a slight advantage in NOx conversion over ZNX alone trace 37. However, as the NSR ratio is increased to obtain higher NOx conversion, the performance advantage of the CSF and ZNX SCR configuration also increases. At the highest NSR levels evaluated (>0.9) the NOx conversion of the ZNX SCR alone configuration appears to be leveling off at ca. 60%. It should be noted that the

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temperature for the steady state condition plotted in Figure 4, lies at the lower edge of the temperature window for optimum conversion activity for the ZNX catalyst alone. The NOx conversion for the CSF and ZNX SCR catalyst configuration, as shown in Figure 4, is nearly 100%. This shows a clear improvement in the SCR reaction by the presence of CSF catalyst 12 up-stream of the ZNX SCR catalyst 14. It also shows excellent utilization of the NH₃ derived from urea for the CSF and ZNX configuration.

In Figure 5 which was generated with the engine at 60% load/345EC° C SCR inlet temperature condition, the maximum NH₃ ~~breakthrough~~ break through is indicated by a trace passing through diamonds designated by reference numeral 40 and the average. NH₃ break through is indicated by a trace also passing through diamonds but designated by reference numeral 41 NH₃ break throughs for the ZNX SCR catalyst alone configuration. Also plotted is the maximum NH₃ break through for the CSF and ZNX SCR catalyst configuration as shown by the trace passing through circles designated by reference numeral 42. At this temperature and condition the ZNX SCR catalyst alone configuration exhibits much increased NH₃ break through, especially at NSR levels greater than ca. 0.55. This is consistent with what would be expected from studying Figure 4 which shows a leveling off of the NOx conversion performance at higher NSR ratios as a result of poorer utilization of NH₃ from urea. In marked contrast, the maximum NH₃ break through for the CSF and SCR configuration was zero at each of the NSR levels tested as shown by trace 41. This is also consistent with Figure 4 which shows for higher NSR ratios a high NOx conversion and thus full utilization of NH₃ from urea.

Replace the paragraph at page 19, line 21 to page 20, line 13 with the following amended paragraph:

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Figure 6 shows, with engine 15 at the 14% load/200EC° C SCR inlet condition, the NOx conversion as a function of NSR for the CSF and SCR catalysts as a trace passing through circles designated by reference

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numeral 44 and the SCR catalyst alone configuration as a trace passing through diamonds designated by reference numeral 45. At this condition the NOx conversion with the ZNX SCR catalyst alone configuration is rather low (10-15%) and is essentially unresponsive to changes in NSR level. The exhaust temperature (200EC) is well below the temperature window normally observed for the ZNX SCR catalyst activity. However, with CSF 12 up-stream of the ZNX SCR catalysts 14 good NOx conversion was observed. The NOx conversion increased with increasing level of NSR until it leveled off at ca. 70% for NSR above ca. 0.63. Specifically, Figure 6 shows that SCR catalyst 14 is catalytically active at light engine loads producing low temperatures of 200EC in that at least 50% of NOx emissions are reduced to N2 by SCR catalyst. As clearly shown by trace 45, ZNX SCR catalyst 14 is not normally catalytically active at this temperature at the space velocities measured. It is now possible to use the CSF and SCR catalyst configuration for low load diesel driving conditions, such as are encountered for LD diesel autos or SUV's.

Replace the paragraph at page 20, lines 14-25 with the following amended paragraph:

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Figure 7 shows, at the 14% load/200EC SCR inlet condition, the maximum NH₃ break through as a function of NSR for the CSF and ZNX SCR catalyst configuration indicated by a trace passing through circles designated by reference numeral 48 and the ZNX SCR catalyst alone configuration indicated by a trace passing through diamonds designated by reference numeral 49. As can be seen, the ZNX SCR alone configuration, trace 49, exhibits NH₃ break through above an NSR level of ca. 0.62 and the NH₃ break through becomes very high at NSR levels above 0.9. The CSF and ZNX configuration of the present invention, trace 48, exhibited zero NH₃ break through for all levels of NSR which were evaluated.

Replace the paragraph at page 20, line 26 to page 21, line 7 with the following amended paragraph:

B'6
Figure 8 is a summary graph and shows NOx conversion as a function of NSR for the CSF and ZNX SCR catalyst configuration of the present invention at all three of the steady state conditions (100%, 60% & 14% load) discussed above. These are the same results shown in Figures 2, 4 & 6, but plotted on the same chart and the traces carry the same reference numerals previously described. As can be seen the NOx conversion as a function of NSR is very similar at each of the test conditions - exhaust temperatures of 470, 345 & 200EC°C. Furthermore, the NOx conversion levels are at or above the theoretical for calculated NSR with the exception of ca. 0.86 NSR at the 200EC°C SCR catalyst inlet temperature shown as trace 44.

Replace the paragraph at page 22, lines 6-18 with the following amended paragraph:

B'7
Figure 10 shows the OICA Cycle Results for the ZNX SCR catalyst 14 alone configuration with the conditions scaled to the normal 300HP engine rating. For this test the average SCR inlet exhaust temperature was 357EC°C. The chart shows the mode-by-mode NOx conversion and NSR level used. More particularly, the NOx conversion, read from the left y-axis, is shown by a trace passing through circles designated by reference numeral 60 and the NSR, read from the right y-axis, is shown by a trace passing through diamonds designated by reference numeral 61. For an average NSR level of ca. 0.985 the weighted NOx conversion over the test cycle was 67.3%. The maximum NH₃ slip observed over the cycle was 241 ppm.

Replace the paragraph at page 22, lines 19-31 with the following amended paragraph:

B'8
Figure 11 shows for comparison the results for the same OICA Cycle as in Figure 10, but for CSF 12 and ZNX SCR catalyst 14 configuration. In Figure 11, the NOx conversion, read from the left y-axis, is shown by a trace passing through circles designated by

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reference numeral 64 and the NSR value, read from the right hand y-axis, is shown by a trace passing through diamonds designated by reference numeral 65. As can be seen for a comparable average SCR inlet temperature of 367~~EE~~EC°C and an average NSR of 0.976 the average weighted cycle NOx conversion observed was 85.1% - nearly 20% higher than for the ZNX SCR alone configuration. There was no NH₃ break through observed over this test cycle.

Replace the paragraph at page 23, lines 5-15 with the following amended paragraph:

B¹⁹
Figure 12 shows the OICA Cycle results for the ZNX SCR catalyst 14 alone configuration. The NSR trace passes through diamonds designated by reference numeral 66 and the NOx trace passes through circles designated by reference numeral 67. As can be seen for an average SCR catalyst inlet temperature of 288~~EE~~EC°C and an average NSR level of 0.921 a weighted average NOx conversion over the test cycle of 58.2% was obtained. This was ca. 9% lower than for the same configuration for the 300 HP test with average temperature of 357~~EE~~EC°C. The maximum NH₃ slip observed over the test cycle was 310 ppm.

Replace the paragraph at page 23, line 16 to page 24, line 3 with the following amended paragraph:

B²⁰
Figure 13 shows the OICA Cycle results for the CSF 12 and SCR 14 catalysts configuration at the 180 HP rating. The NSR trace passes through diamonds designated by reference numeral 68 and the NSR trace passes through squares designated by reference numeral 69. As can be seen for an average SCR catalyst inlet temperature of 296~~EE~~EC°C and with an average NSR of 0.963 a weighted average NOx conversion of 89.9% over the cycle was obtained. This was slightly better than for this configuration at the 300HP rating at an average 367~~EE~~EC°C which temperature, in turn, is better matched to the ZNX SCR catalyst activity window. However, its possible that the lower exhaust flows and thereby lower GHSV's (space velocity through the SCR) for the 180

B-20
HP condition compensated for the lower temperature condition. For the 180 HP condition the CSF and ZNX SCR configuration gave over 30% higher weighted average cycle NOx conversion than did the ZNX SCR alone configuration. The CSF and ZNX configuration exhibited no NH₃ break through over the test cycle.

Replace the paragraph at page 25, line 10 to page 26, line 13 with the following amended paragraph:

1) In general summary, the Steady State Tests showed:

a) A slight advantage of CSF and SCR over SCR alone as a function of NSR at high inlet temperature (470EC°C). Both configurations attained ca.80-90% NOx conversion for NSR = 0.8-0.9;

b) For lower inlet temperatures (345EC°C & 200EC°C) the CSF and SCR configuration gave substantially better NOx conversion than the SCR alone configuration at all NSR levels, but especially at higher NSR's. CSF and SCR attained 70-90% NOx conversion for NSR = 0.7-0.9.

Activity for NOx conversion for SCR alone decreased with decreasing inlet temperature while CSF and SCR maintained activity;

B-21
c) The CSF and SCR system gave 70% NOx conversion at 200EC for NSR 0.7-0.85 and SCR alone configuration gave only 10%. CSF and SCR is therefor viable for light load and light duty diesel applications;

d) The more effective utilization of the reductant by this invention results in less unreacted ammonia leaving the catalyst. In these experiments virtually all of the available reductant (ammonia) was used to reduce NOx and therefore no unreacted ammonia could be detected at the catalyst exit;

and,

2) The ESC Cycle Testing showed:

e) The 300 HP rated modes resulted in an average exhaust temperature of ca. 360EC°C. The SCR catalyst alone (two parallel bricks) gave 67% weighted cycle NOx reduction for NSR 0.98 with NH₃ slip. The CSF and SCR (two parallel bricks) system gave 85% weighted cycle NOx reduction for NSR's of 0.98 with no NH₃ slip; and,

B21
f) The 180 HP rated modes resulted in an average exhaust temperature of $290\text{E}^{\circ}\text{C}$. Weighted cycle NOx reduction of 58% was attained with SCR alone at NSR=0.92 with NH_3 slip. The CSF and SCR (two bricks in parallel) system gave 90% weighted cycle NOx reduction for NSR = 0.96 with no NH_3 slip.

Replace Table 3 at page 27, line 25 to page 28, line 1 with the following amended Table 3:

Table 3
NO₂/NOx Ratios

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		Engine-Out	Engine-Out	CSF-Out	ZNX-Out (NSR >0.8)
Load	Temp	NOx (ppm)	NO ₂ /NOx Ratio 22A	NO ₂ /NOx Ratio 22B	NO ₂ /NOx Ratio 22C, 22D
100%	468E ^o C	770	0.3%	12.7%	0.0%
60%	345E ^o C	420	1.2%	45.4%	0.0%
14%	200E ^o C	214	4.6%	28.2%	0.0%

Replace the paragraph at page 30, line 9 to page 31, line 15 with the following amended paragraph:

B23
Definition notwithstanding, when a hydrocarbon reductant is used to reduce NOx over a catalyst, the catalyst is typically referred to as a lean NOx catalyst and lean NOx catalysts are typically classified as either a low temperature NOx catalyst or a high temperature NOx catalyst. The low temperature lean NOx catalyst is platinum based (Pt-based) and does not have to have a zeolite present to be active, but Pt/zeolite catalysts are better and appear to have better selectivity against formation of N₂O as a by-product than other catalysts, such as Pt/alumina catalysts. Generally a low temperature lean NOx catalyst has catalytically active temperature ranges of about 180 to 350E^oC with highest efficiencies at a temperature of about 250E^oC. High temperature lean NOx catalysts have base metal/zeolite

compositions, for example Cu/ZSM-5. High temperature NOx catalysts have a lower temperature range of about 300-350EC°C with highest efficiency occurring around 400EC. The broader scope of this invention uses either high or low temperature lean NOx catalysts with an HC reductant, as described for example in Figure 14A. Because of the potential for ammonia to form NOx, it is considered desirable to introduce the ammonia to the exhaust gas at the in-between position shown in Figure 14A. However, an HC reductant does not raise the same concerns so that an HC reductant can be introduced into the exhaust gas as shown in Figure 14B. Further, it is therefore possible to construct a single catalyst brick 13 which has a catalyzed soot filter at its entrance portion and a lean NOx catalyst extending over its exit portion as shown in Figure 14C with the HC reductant introduced to the exhaust gases at the inlet of the combined catalyst. The catalysts could, of course, be separate and combined in a single cover. Again, as of the date of this invention, specific tests using lean NOx catalysts have not been performed. However, based on observations during testing of the preferred embodiment using ammonia reductant, it is believed that comparable results may be obtained using lean NOx catalysts with an HC reductant.

Replace the paragraph at page 36, line 24 to page 37, line 17 with the following amended paragraph:

As indicated above, light diesel engines have lower exhaust gas operating temperature ranges than heavy duty diesel engines. As a matter of distinction or characterization and generally speaking, the lower normal operating temperature range of light duty diesel engines (i.e., diesel engines on autos, SUVs, pick-up trucks) produce exhaust gases in the temperature range of 150-250EC°C in contrast to the lower normal operating temperature range of heavy duty diesel engines in vehicles such as trucks which may be in the range of 235-500EC°C. Peak temperatures are considerably higher. As shown and for the same space velocity, the ZNX SCR catalyst with the upstream CSF catalyst becomes catalytically active at lower temperatures than those

B24
temperatures at which the ZNX SCR catalyst would become catalytically active if directly exposed to the combustion gases produced in the combustion chambers of engine 15 (i.e., the exhaust gases). Any SCR catalyst using a nitrogen reductant will have a lower catalytically active temperature (at the same space velocity) when used in the arrangement of the invention. Further, the tests show that the reduction in the catalytically active temperature of the ZNX catalyst was not accompanied with any noticeable reduction in the efficiency of the ZNX SCR catalyst. Thus, the invention has specific application to light duty diesel engine applications.

At page 37, add the following new paragraph between the paragraph ending at line 17 and the paragraph beginning at line 18 as follows:

B27
In a specific embodiment of the present invention there is a wall-flow type catalyzed soot filter adjacent to the diesel engine. A valve is downstream of said soot filter's exit in fluid communication with a nitrogen reductant and with said exhaust gases after exiting said soot filter. There is a means for regulating said valve to control the quantity of said nitrogen reductant admitted to said exhaust gases. A nitrogen reductant SCR catalyst is downstream of the valve and said soot filter. The SCR catalyst has a set temperature at which said SCR catalyst becomes catalytically active for a set space velocity if said exhaust gases pass through said SCR catalyst with a set quantity of reductant immediately upon exit from said engine that is higher than the temperature at which said SCR catalyst becomes catalytically active when said exhaust gases pass through said SCR catalyst at said set space velocity with said set quantity of reductant after passing through said soot filter.